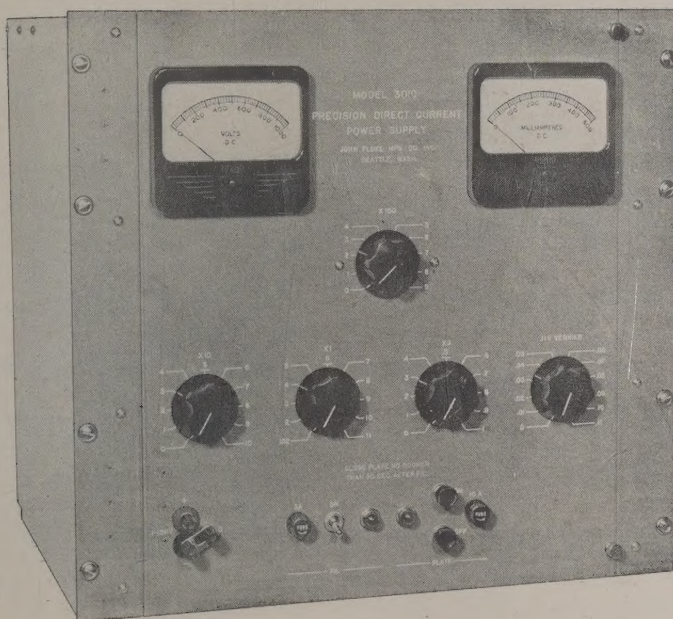


FLUKE

TECHNICAL DATA

301C**POWER SUPPLY**

FEATURES

1.02 to 1012 VDC - 0 to 400 MA
0.005% Regulation
Chopper Stabilized
Standard Cell Reference
500 Microvolt Resolution
0.1% Calibration Accuracy

The Model 301C is a chopper-stabilized, standard cell referenced, calibrated, precision DC power supply which will satisfy the most exacting requirements of laboratory or production line.

With its 400 milliampere, 1 KV output, it is truly a brute force supply. Because of conservative design this supply may be operated indefinitely within specifications for any rated input or output.

Five decade voltage controls afford resolution of ± 50 microvolts over the entire operating range, and absolute accuracy is better than $\pm 0.1\%$. Use of a standard cell reference and chopper stabilization imparts to the 301C output voltage stability of better than $\pm 0.01\%$ long term.

A unique hinged panel affords instant access to the printed circuitry without removing the instrument from its rack. This construction also isolates the standard cell and precision wirewound sampling strings from all heat generating elements. A compact, rugged unit of incomparable performance, the 301C stands alone in its field.

SPECIFICATIONS

INPUT VOLTAGE: 117 volts $\pm 10\%$, 60 cycles, single phase (220 volt model available on request).

INPUT POWER: 875 watts fully loaded, 190 watts standby.

OUTPUT VOLTAGE: 1.02 to 1012 volts DC.

OUTPUT CURRENT: 0 to 400 milliamperes.

OUTPUT POLARITY: Either terminal may be grounded, or both may be left floating.

OUTPUT CONNECTOR: Insulated binding posts on 3/4" centers.

REGULATION vs. LINE: 0.005% or 1 millivolt for $\pm 10\%$ line voltage change.

REGULATION vs. LOAD: 0.005% or 1 millivolt for 200 milliamperes load current change.

STABILITY: $\pm 0.005\%$ per hour after 30 min. warmup, less than $\pm 0.01\%$ per day.

OUTPUT IMPEDANCE: Less than 0.05 ohms DC.

TRANSIENT RESPONSE TIME: Less than 200 microseconds.

REFERENCE ELEMENT: Low hysteresis standard cell.

EQUATING ELEMENT: Low Noise chopper.

RIPPLE: Less than 2 millivolts RMS.

VOLTAGE CALIBRATION:

- 9 - 100 volt steps
- 10 - 10 volt steps
- 10 - 1 volt steps
- 10 - 0.1 volt steps
- 1 - 0.11 volt vernier

VOLTAGE RESOLUTION: 50 microvolts at any output voltage via 0.11 volt vernier.

VOLTAGE RESETTABILITY: $\pm 0.01\%$.

CALIBRATION ACCURACY: $\pm 0.1\%$ or 2 millivolts.

METERS: 4" voltmeter 0-1000 volts. 4" milliammeter 0-500 milliamps.

MOUNTING: Standard relay rack, panel slotted to RMA standards. Supply equipped with removable steel cabinet 17-1/2" x 19" x 15-1/2" deep for bench use.

WEIGHT: 138 lbs. with cabinet.

FINISH: Smooth grey baked enamel, panel machine engraved.

PRICE: \$985.00 f.o.b. factory, Mountlake Terrace, Washington.

The right is reserved, without notice, to make such changes in equipment, design, or components as engineering or manufacturing progress may warrant.

Prices subject to change without notice.

9-20-61

Litho in U. S. A.

Electronics FOR INDUSTRY

FLUKE

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ADDENDA SHEET FOR 301C TEST INSTRUCTIONS

Section XVI Regulation vs. Line & Load change paragraph to read as follows:

"Assuming 'Noisy When Tapped' test proves OK, proceed to check line and load regulation. With 801 nulled at 498v and line at 117v and load selector switch at 996 switch in load--output must not vary more than 75mv (37.5mv on 801 since 2 to 1 divider is being used). If load regulation is high, refer to troubleshooting file. Next vary line from 130 to 105 volts--output must vary less than 75mv. If line regulation is too high, change V17. It may be necessary to try several 6AU6's. Check line and load reg. at 496, 110 two ways, 40, 4 and 1.02 volts. For poor line reg. at 110v with X100 sw. at 0 and lower voltages change V18 and V19 in this order. Maximum tolerances for each output are on the test record."

On data sheet make changes as follows:

Under Regulation, Line & Load, change tolerances for conditions negative ground, floating ground, and positive ground.

50 mv to 75 mv
25 mv to 38 mv
5.5 mv to 8 mv
2 mv to 3.5 mv
1 mv to 1.5 mv

dmb
4/24/60

MODEL 301C TEST PROCEDURE

I. Visual Inspection

This inspection must be performed before the supply is connected to the power line. First, remove plug from the standard cell socket. Check every single solder connection carefully. Adopt an orderly checking route and follow it each time. Touch each connection with an insulated probe. A casual glance at a soldered connection on a tube socket is a waste of time. One lead buried under two or three others may be completely bare of solder and not be noticed by a casual glance. If any connection looks questionable, resolder. Pay particular attention to the soldering of terminal lugs to the copper foil on the printed circuit board. Solder must be flowed from the eyelet or terminal lug to the foil since the mechanical connection alone is sometimes very poor electrically. Check every single solder connection on the chassis, relays and front panel. Examine all connections to the multi-deck switches on the front panel, checking carefully for unsoldered jumper wires and poorly soldered wirewound resistors. Check the first resistor (between 1.02 and 2V positions) on the X1 switch to be sure that it is a 441.36 Ω units, not 450 Ω . Check the connections to the terminal strip on the left side sheet. Check every terminal nut or screw for tightness. Be certain brass bolt is used to mount R98-R99 combination using small, permanent magnet, if necessary.

Check fit of panel hinged section. Panel must fit with less than 1/32 - inch gap all around and tops of all three panel sections must be in line within plus or minus 1/32 - inch. Read all engraving on front panel for error, omissions or flaws.

Inspect back of supply for missing tubes and bad solder connections. Check all connections on sockets of 866 tubes and on plate feed strip for 807 tubes. Be sure all plate resistors on both sides of strip are 100 Ω . Be sure all dropping resistors on large capacitor bank are 150K and bare jumper wires are not touching a capacitor mounting lug that they shouldn't. Remove plate caps from 866 tubes and drape across tubes away from chassis in preparation for further tests. Remove shorting link from binding posts.

II. Ohmmeter Check

- A. Check resistance across C7 - screen supply capacitor. It must be at least 10K.
- B. Check resistance across C1 - main filter capacitor. It must be at least 30K.
- C. Check both ceramic capacitors inside top of cabinet. Both should read infinity. (With shorting link off and R45 thyrite disconnected).
- D. Check resistance across C8 and C11 in the plus 200 and minus 200 volt supplies. Must be at least 500 K.
- E. Check resistance between G post and plus and minus posts in turn. Must be at least 500 megohms.

- F. Connect ohmmeter across output binding posts and check resistance with all knobs set to zero. Should read 450Ω . Turn vernier control fully clockwise - reading should increase to 500Ω . Turn X. 1 control fully CW - reading should increase in 45Ω steps to 900Ω . Turn X 1 fully CW - reading should increase in 450Ω steps to $5,400\Omega$. Turn X10 control full CW - reading should increase in 4.5 steps to approximately 48K. The shunting effect of the voltmeter will begin to show up here and will cause reading to be about 2 K low - hence 48 K instead of 50K. Finally, turn X100 control CW - here the 1 megohm shunting resistance will really be noticed - merely check to see that the resistance increases at each step and that the resistance with all dials set to maximum measures around 310K.
- G. Clip black ohmmeter lead to the black wire in the four wire cable from PCB to X100 switch. Connect the read probe to the green wire of the four wire cable. Set all voltage knobs to zero initially and proceed as follows:

<u>Switch Positions</u>	<u>Resistance</u>
X100 - 1 thru 9, others zero	-0-
X100 - 0 X10-2 thru 10	470K
X100 - 0 X10-1	220K
X10 - 0 X1-5 thru 11	110K
X10 - 0 X1-4	88K
X10 - 0 X1-3	66K
X10 - 0 X1-2	44K
X10- 0 X1-1, 02	22K

- H. Connect ohmmeter from green to white lead next. Set X100 switch to zero. Must read zero Ω . Set X100 switch to 1 thru 9 - meter must read 2.2 megs.

III. Transformer Tap Check

Connect shorting link to negative output post.

To check plate transformer taps on S1A, connect line cord of the 301C to a 6.3 volt source and connect a zero to 150VAC voltmeter from the negative binding post to one of the two 866A plate caps. Hold relay Ck1 armature in and note voltmeter reading for each position of the X100 switch - meter should read as follows:

<u>X100 Switch Position</u>	<u>Voltage</u>
0, 1, 2	38V
3, 4	52V
5, 6	67V
7	75V
8	83V
9	90V

The important thing to note is that the voltage increases as the knob is turned clockwise. If any voltages are reversed, it indicates improper connection of the primary taps to the switch either at the switch itself or at the terminal board.

IV. Initial Filament and B plus check

Connect supply to 117 volt line and throw filament switch to "on" position. Observe the two neon bulbs on PCB and be sure they glow within seconds of switching on. Next check that all tubes are lit, including two 5651 tubes and the OA3 tube which should glow bright orange. Listen to be sure chopper is operating as evidenced by a definite hum.

V. Screen Supply

Check 807 screen grid supply with line voltage left at 117 volts. Connect neg. lead to VTVM to pos. output post and read screen voltage on the pos. terminal of the screen capacitor to the left of the PCB. This voltage should read about 340 volts with ripple less than .5 volts.

VI. Positive 200 Volt Supply

With line voltage set at 117 volts check plate voltage of 6AQ5 - should run 400 volts plus or minus 15 volts. Ripple should not exceed 2 volts. Next check regulated output voltage - must not be more than 5 volts above or below 202 volts. Ripple should not exceed 5 millivolts. V17 should be removed from its socket for this reading to eliminate amplified noise from the chopper. Check the line regulation of this supply by varying the line voltage from 105 to 130 volts and noting the E_0 difference - should not exceed .4 volts.

VII. Negative 200 Volt Supply

Remove OA3 tube from its socket during this check - replace 6AU6 in its socket. Check the negative 200V supply following same procedure as for positive 200V supply. Plate voltage of 6AQ5 should run 385 volts plus or minus 15 volts. Regulated output, ripple and line regulation are same as for other supply.

VIII. 807 Heater Voltages

Check heater voltage of each of the seven 807 tubes. Using an AC VTVM - measure drop across each of the 807 heaters (pins 1 and 5). Must measure approximately 6.3 volts and all seven must lie within 0.4 volts of each other. If any one tube reads much higher or lower than the other six, replace it and recheck heater voltages.

IX. Remaining Heater Voltages

Check all remaining heater voltages. Read voltage at 6AG7 socket - should read 6.3 volts. Blue and green lead connected to V19 (6AX7) should read 6.3 also. The two sets of terminals at the bottom of PCB marked minus HH and plus HH should also read 6.3 volts. The 5V4 filament should read 4.7 volts. Use caution when reading this voltage since the voltmeter case will be at approximately 400 volts hot.

X. Element Potentials V17, V18, V19, and V20

Check element potentials in AC and DC amplifiers. Clip black probe to neg. output post. Switch X100 switch fully CCW. Plates (Pin 5) of two 6AU6 tubes (V17 and V18) should run from 55 to 70 volts and screen grids (Pin 6) should run 30 to 40 volts. Control grid (Pin 1) of V17 should measure minus 1.2 volts and grid of V18 should measure minus 1.0 volts (using a VTVM). Voltage at pin 1 of V19 should measure 56 to 106 volts as P3 is rotated from one extreme to the other. After recording range, set Pin 1 to 85 volts. Remove negative probe from negative output post and connect to minus 200 volt bus. Check voltage at pin 5 of V20 - should measure 72 volts plus or minus 2 volts. This concludes check of amplifier DC potentials.

XI. Relay Operation

Be sure standard cell remains unplugged for this test. First, check relay CK4 on the right hand side of the supply mounted on the standard cell cover. This relay is operated by DC voltage from the positive 200 volt supply. To check its pull-in, hold in on the armature of relay CK2. This is the large antenna type relay on the right side sheet. When the armature is held in, CK4 should pull in and hold until the armature is released. Be sure that the plate caps of the 866 tubes are not on the tubes and are suspended away from any metal chassis parts. Now press the ON button and watch to be sure that both relays CK1 and CK2 on the right side sheet pull in. If a loud buzzing is heard when the line is varied from 100 to 130 volts, make adjustments at this time to the relay blades or spring to eliminate the foregoing buzzing. When all three relays are operating satisfactorily, shut supply down and place plate caps on 866 tubes and plug in standard cell plug. Set up 496 volts on front panel dials and select thyrite varistors.

XII. Thyrite Varistors

Thyrite Varistors are used as R44 and R45. These are non-linear resistors selected for use in this circuit to set the rate at which the output of the supply rises or falls when the high voltage is switched on or dialed higher or lower. These resistors are paired so that the current that they draw at a given voltage (3 volts) is in a ratio of approximately 2 to 1, the feedback resistor (R45) drawing twice the current of the chopper resistor (R44). This current, or inversely, this resistance results in a smooth rise rate of about 100 volts per second.

When the varistors have been selected, solder them in place in a temporary fashion without cutting their leads off. Use caution to conduct heat away from the body of the resistor by holding point nose pliers between soldering iron and resistor body. Feedback resistor (R45) is installed between two lugs above 12AX7 socket (V19) on foil side of PCB. The left lug can be identified by a 27K 1-watt resistor attached to it. The right lug is on the ground foil. Chopper resistor (R44) is installed between the afore-mentioned ground lug and the lug directly below it, identifiable by a 1 mfd at 200 volt polystyrene capacitor connected to it.

After the varistors are installed, temporarily ground the filament lug (pin 9 of V19) to the adjacent ground lug. The supply is now ready for testing of the regulated high voltage output.

XIII. Main Supply Initial Operation

Before pushing the Plate "on" button, double check that the 866 Plate caps are in place on the tubes, the standard cell is plugged in and all tubes that were removed during previous tests are in their proper sockets. Negative output post should be linked to the "G" post. Front panel dials should be set at 496 volts. Connect ripple meter through a blocking capacitor to output posts and push "ON" button being ready to push "OFF" button if front panel meter does not rise steadily at about 100 volts per second to approximately 500 volts and stop.

If voltage rise is too fast or oscillates several times before coming to rest, try another thyrite pair. Ripple meter is good way to observe oscillation if present. If voltage rises too slowly it indicates another pair should be tried, also. Both R44 and R45 affect the rise time. If R44 appears as a very high resistance at a very low voltage, the rise time will be very short. For instance, a resistor which has a resistance of 330K at 2 volts would give a rise time of 400 volts per second. If R45 appears as a very low resistance at a very low voltage, the rise time will also be short. A feedback thyrite of 100K at 3.8 volts would give a rise time of 250 volts per second. Note that the "sense" is opposite for R44 and R45--that is, a high resistance R44 causes fast rise whereas a low resistance R45 causes fast rise also.

If voltage rises at proper rate but continues on above set voltage and loses control, it is reasonable to assume that all circuitry from the input (pin 7 of the 12AX7) on, is operating properly but the reference signal is absent due to malfunction in the sample string, chopper circuit or AC amplifier section. For more detailed trouble-shooting aids, refer to trouble-shooting file. If trouble is not quickly located, a signal tracing procedure should be employed to check the AC amplifier and attenuator. To do this, disconnect the standard cell plug and connect millivolt source from pin 2 of the chopper to the negative bus. Trace signal with scope and AC VTVM into grid of V17 and out of plate. Next follow through attenuator to grid of V18 making measurement on white

wire in 4 wire cable to X100 switch. The scope hookup would load down the grid of V18. The gain of the AC amplifier is 15,000 with the X100 switch in positions 1 through 9. A 1 mv DC voltage at the input to the chopper should produce a 15 v AC signal at the plate of V18. If OK, check action of synchronous rectifier by connecting DC VTVM across C19. The 15 v AC signal should appear as a 15 v DC voltage across C19. If no DC, check R42, R43, R44, C17, and C19.

If voltage rises immediately to the main supply voltage (which, with X100 sw. at 4, would be about 800 v) and fails to regulate, it can be assumed trouble is in 12AX7, 6AG7 or 807 stages. A gassy 807 can cause uncontrolled conduction and should be eliminated by substitution being careful to shut down supply and allow C1 to bleed for 30 seconds before touching plate caps. Use of the millivolt source as described earlier can be extended to trace signal through the 12AX7 and 6AG7 stages. Varying the millivolt signal into the chopper should cause a readable voltage change at pin 6 of the 12AX7. A similar change should be seen at the plate (pin 8) of the 6AG7, but, since this plate voltage is supplied by the 807 screen supply, the high voltage must be on and care must be exercised while making these readings.

Only a general outline of troubles and cures can be given here, but more specific symptoms and possible causes may be found in the 301C troubleshooting file.

Assuming initial operation satisfactory, proceed with check of offset, regulation, ripple and calibration accuracy.

XIV. Offset

****A word of caution is in order at this point.** Due to the rise and fall rate of the 301C power supply output, damage to certain precision wirewound resistors can result from switching the front panel dials too rapidly. A study of the schematic would reveal, for instance, that switching from several hundred volts to minimum output (1.02 v) rapidly would switch all sample resistors across the output out of the circuit except R98, R99, and P2 totaling only 460 Ω . Since the output drops slowly, a large current will flow through the resistors, damaging them beyond use. A good rule to follow is:

****NEVER SWITCH THE X100 SWITCH FROM 1 to 0 WITHOUT X10 SWITCH BEING AT LEAST UP TO 6.**

Offset refers to the difference in the output of the supply when pin 7 of the 12AX7. is varied from plus .04 volts to minus .04 volts, the operating limits of this stage for best linearity. To check offset, switch supply down to 1.02 volts. Connect VTVM from negative output post to pin 7 of V19 and set plus .04 volts by adjusting P3 - the 10K pot on the PCB. Read output on 801 and record in proper place on test form. Readjust P3 to bring pin 7 V19 through zero to minus .04 volts and record output on test form. Subtract the smaller output voltage from the larger and record this as the offset - should not exceed .004 volts. If it does, try another pair of Thyrites and recheck offset. Before proceeding, set P3 so output of supply is 1.0190 volts.

XV. Ripple

Ripple should first be measured in the negative grounded mode so the link should be fastened from the negative output post to the "G" post. The 301C load should be plugged into the output posts first then the blocking capacitor being certain that the black of common lead is connected to the grounded output post.

Set front panel controls to 996 v and load dial to 996 also. Push "ON" button and note total rise time in seconds and record in space provided in section XII on first page of test record.

Check ripple at no load through the input voltage range of 105 to 130 volts. If ripple is in excess of 1 mv, try reversing AC power to coil of CK2. Next try replacing 6AU6, 6AG7, and 12AX7 in this order. Other possible causes of high eo are defective feedback capacitor C22, leaky C19, leakage heater to grid circuit of 6AG7, incorrect value of capacitor used in corrective network (C21-R53), too large a value will lower the DC amplifier gain at low frequencies. Also recheck Aux. Supplies and Screen Supply for Excessive ripple.

Next switch in load-ammeter should read 400 ma and ripple must stay under 2 mv over the 105 to 130 volt input range. Decrease line voltage with load still on and note at what voltage supply loses control. This must happen at less than 100 volts line. If in excess of this, check the 866 mercury vapor rectifiers visually to see that they both are glowing equally. Excessive drop across one of the 807 plate resistors could cause this. With supply shut down check these resistors with an ohmmeter - should read 100 Ω plus or minus 10%. 807 tubes should be checked by substitution and screen supply remeasured to make certain it reads at least 320 volts at 117 volts line. If less than this, replace 5V4.

If excessive ripple shows up under load only. it may be a problem of poor load regulation which, when cured, would result in reduced eo.

In the event difficulties are encountered which are not covered here, refer to 301C Trouble-shooting File under Ripple.

Assuming ripple is less than 2 mv (preferably less than 1 mv) proceed with the second page of the test record. Measure and record ripple at no load and full load at the following voltages: 996, 496, 110, 40, 4, and 1.02.

Remove shorting link and repeat readings at each output being careful that load switch is set at proper voltage each time load is applied. During any tests in this, the floating mode use extreme care not to come into contact with the scope of AC VTVM case since they may assume some elevated potential.

Shut down main supply and connect shorting link from positive output terminal to "G" post. Reverse blocking capacitor connection so that the hot lead is on the ungrounded negative post. Bring supply into operation and record ripple in the same outputs as before.

If supply shows any tendency to oscillate at high load currents, replace C26, C21, and C20 in this order.

XVI. Regulation vs. Line & Load

With supply shut down, disconnect blocking capacitor and load and reconnect shorting link from negative to "G" post. Connect a 2 to 1 divider to output posts observing polarity then reconnect load. Connect 801 to output of divider. Set 301C to 996 v and bring into operation. 801 should null at approximately 498 v. With the 801 in the 10 v null range, adjust P2 (the 5 Ω Hundinger pot on the plexiglass board mounted on the back of the output posts) through its full range, making sure its operation is not intermittent--if intermittent or rough, replace and recheck new unit. Tapping this pot lightly with screwdriver handle may reveal an intermittent condition. When satisfied P2 is OK, adjust it so 801 nulls at 498 v on the .1 v null range.

The 301C is a stable instrument and should be able to stand considerable vibration and jarring without affecting the output. It is a must that it pass this test as surely as it passes ripple, regulation and calibration. Using a long insulated probe, methodically tap all components watching for abnormal deflection on the 801. It may help to connect the ripple meter to the output to watch for microphonic tubes. The PCB in the area of V17 is normally somewhat sensitive to tapping due to the high gain in the AC amplifier but a microphonic tube in V17 must never get by this test. V19 and V20 are also troublemakers if they are at all microphonic. Use the probe to flex the PCB in several places. This is a good method of revealing hairline breaks in the foil, rosin or coldsoldered joints or solder blobs almost bridging two separate foil circuits. In a like manner flex the 807 plate resistor strip to check for bad solder joints. Tap all wirewound resistors and flex their leads to test their connection at switch terminal lugs. Tap each switch and relay and flex cables connecting panel to PCB, also test standard cell wiring. As a final test, slap the sides and top of the cabinet soundly and pound the test bench to see if any of these jarrings cause instability.

Assuming "Noisy When Tapped" test proves OK, proceed to check line and load regulation. When 801 nulled at 498 v and line at 117 v and load selector switch at 996 switch in load-output must not vary more than 75 mv (37.5 mv on 801 since 2 to 1 divider is being used). If load regulation is high, refer to trouble-shooting file. Next vary line from 130 to 105 volts - output must vary less than 75 mv. If line reg. is too high, change V17. It may be necessary to try several 6AU6's. Check line and load reg. at 496, 110 two ways,

40, 4, and 1.02 volts. For poor line reg. at 110 v with X100 switch at 0 and lower voltages change V18 and V19 in this order. Maximum tolerances for each output are on the test record.

Line and load regulation should next be checked in the floating mode. Cast the shorting link loose and proceed in the same way as before, exercising caution not to touch the metal 801 cabinet when working at the higher outputs.

Finally, regulation is checked in the positive grounded mode. With high voltage off, connect shorting link from pos. to "G" post. Link the 801 input posts in the same manner as the 301 output, being certain that the positive posts on both 301C and 801 are linked to their cases via their "G" posts.

Check line and load regulation at same outputs as other modes.

XVII. Linearity

With high voltage shut down connect shorting link from neg. output post to "G" post. Using 801 and divider box recalibrate supply to 996 closely as possible on the .1 null range. Switch down one position at a time on the X100 switch noting the voltage difference - must not exceed 50 mv per switch step (25 mv thru divider). At 496 the divider can be dispensed with for greater ease in dialing 801. After the X100 switch has been checked, dial the X10 switch and X1 switch to maximum and null 801 on .01 range. Switch down one step at a time on the X10 switch noting difference at null - must not exceed 5 mv per step. Check X1 switch in same manner - difference should not exceed .5 mv per step, however, the lower steps on this switch may exceed this slightly but must never exceed 2 mv. Similarly check the X.1 switch and the .11 v vernier with 2 mv as the maximum tolerance.

XVIII. Meter Accuracy

Set the output to 1,000 volts and check voltmeter reading (be sure meter was carefully zeroed with high voltage off). Should be within 2% or 20 v of 1 kv. Check meter down through all positions of the X100 switch watching for poor linearity. A few meters tend to read slightly low over their entire range. These cases may be corrected by shunting one of the meter divider resistors with a 3.3 megohm 1/2 watt unit. Replace any questionable meters.

To check the ammeter set output to 996 and supply 400 ma load. Meter should read within 2% or 400 ma.

FINAL PRE-CALIBRATION STEPS

Since thyrite resistors were temporarily installed and have since been proven OK, they should now be permanently soldered in place with shortened leads being careful to conduct heat away from disc.

Amplifier filament green and blue leads should now be permanently soldered in place dressing them across PCB neatly cutting excess from lead going to pins 4 and 5. Be sure proper lead gets grounded.

Double check any other solder joints that may have been disturbed in troubleshooting and clean up any bits of loose solder, insulation, etc.

The supply should now be ready for calibration and stability run.

301C TEST RECORD

Sheet 1 of 2

Customer P. O. # _____ Serial No. _____ Technician _____

1. Visual Inspection
2. Ohmeter Check
3. Plate Transformer Tap Check
4. Initial Filament & B Plus Check
5. Screen Supply
Es 807 _____ v
es 807 _____ v
6. Positive 200 Volt Supply
Ek 6AQ5 _____ v
ek 6AQ5 _____ mv (remove V5 to read)
Ek 6AQ5 _____ mv (line reg. 100-130 v line)
7. Negative 200 Volt Supply
Ek 6AQ5 _____ v
ek 6AQ5 _____ mv (remove OA3 to read)
EK 6AQ5 _____ mv (line reg. 100-130 v line)
8. ef 807
9. ef remaining tubes & chopper
10. Element Potentials V5, V6, V7, V8, (turn X100 sw. fully CCW)
Ep V17 _____ V Ep V18 _____ V
Es V17 _____ V Es V18 _____ V
Eg V17 _____ V Eg V18 _____ V
(Set at 85 V)
11. Relay Operation
CK2 Pull-in
CK1 & CK2 pull-in Relays pull-in down to _____ v line.
12. Thyrite Varistors
Rise time to 1000v _____ sec.
(Plug in std. cell plug)
13. Main Supply Initial Operation
(Note if satisfactory, or, if trouble is encountered, state briefly)
14. Offset
Eo at 1.02 w/pin 7 of V7 set at minus .04v = _____ v
Eo at 1.02 w/pin 7 of V7 set at plus .04v = _____ v
Difference in Eo at 1.02 (offset) _____ v (.004v max.)

301C TEST RECORD

Date: _____ Serial No.: _____ Technician: _____

Regulation				Ripple	
Output	Line	Load	Tolerance	No Load	Full Load
<u>Positive Ground</u>				<u>No Reading Above 2 mv</u>	
1000	_____	_____	75 mv	_____	_____
110 100 at 0	_____	_____	8.25 mv	_____	_____
1.02	_____	_____	1.5 mv	_____	_____
<u>Floating Ground</u>				<u>No Reading Above 2 mv</u>	
1000	_____	_____	75 mv	_____	_____
10 100 at 0	_____	_____	8.25 mv	_____	_____
1.02	_____	_____	1.5 mv	_____	_____
<u>Negative Ground</u>				<u>No Reading Above 2 mv</u>	
1000	_____	_____	75 mv	_____	_____
10 100 at 0	_____	_____	8.25 mv	_____	_____
1.02	_____	_____	1.5 mv	_____	_____
<u>Linearity</u>				<u>Meters</u>	
X100 _____ X10 _____ X1 _____				Voltmeter _____ Ammeter _____	
X.1 _____ Vernier _____				Thyrites _____	

<u>Calibration & Stability Check with K Pot</u>		
<u>Linearity Check - Using Oil Bath Divider</u>		<u>Check Stability at Max. Eo in Pos. Pol, No Load, 120V Line</u>
<u>Dial Setting</u>	<u>Deviation in ppm</u>	<u>Time</u> <u>K-Pot</u> <u>Polarity</u>
1000		
900		
800		
700		
600		
500		
400		
300		
200		
100		
50		
10		
5		
1.02		

301C TROUBLE SHOOTING

S=Symptom

C=Possible Cure

HIGH VOLTAGE LOAD REGULATION

- S. Very poor load regulation at all outputs and possibly after a time won't reach set voltage.
- C. Replace 6AG7.

- S. Poor load regulation at all outputs.
- C. Make sure that sample connection at output posts make a good point source contact so that there is no IR drop between feed to binding post and reference sample takeoff.

- S. Very poor load regulation, combined with door shift. (output voltage shifts as door is swung 45°).
- C. Make certain bolt that mounts R98 (457.3Ω) is not a steel bolt. This bolt should be brass.

- S. Load regulation slightly out of tolerance.
- C. Try reversing phase of chopper coil. Line regulation may change slightly.

- S. Output drops drastically under load.
- C. Look for defective 866 mercury vapor rectifier or improper value 807 plate resistors. High resistance path in main supply to plates of 807 tubes.

- S. Load regulation slightly out of tolerance at 110 V (X100 SW at 0) and 40 v.
- C. Replace R-33 (470K) with a 680K unit and recheck.

- S. Poor load regulation at all outputs. Poor line regulation and Hi eo also.
- C. Reverse phase of CK2 coil.

- S. Slightly out of tolerance. Load regulation from 40 v on down.
- C. Resistance of binding posts. Try reading Eo from back of posts.

301C TROUBLE SHOOTING

S-Symptom

C-Possible Cure

HIGH VOLTAGE LINE REGULATION

- S. Poor line regulation at outputs above 110 volts (with X100 switch in position #1).
- C. Replace V17 (6AU6). It may be necessary to try several. Check ripple with new tube.

- S. Poor line regulation at outputs of 110 volts and below. (With X100 switch in zero position.)
- C. Replace V19 (12AX7) and V18 (6AU6). It may be necessary to try several. Double check ripple with new tube.

- S. Poor line regulation at 1.02 (5 mv) and high eo (2 m).
- C. Amplifier filaments not grounded.

- S. Impossible to get line regulation within tolerance after trying several tubes.
- C. Reverse blue and green Amp. filament leads and select ground for lowest ripple.

- S. Line regulation slightly out of tolerance at 110 volts (X100 switch at 0) and 40-v.
- C. Replace R-33 (470K) with 680K unit and recheck.

- S. Poor line regulation at all outputs. Poor load regulation and Hi eo also.
- C. Reverse phase of CK2 coil.

301C TROUBLE SHOOTING

S-Symptom
C-Possible Cure

AUXILIARY SUPPLIES

- S. High ripple or poor line regulation.
- C. Virtually always changing 6AU8 will cure these troubles. It may be necessary to try several tubes.

- S. Jitter in +Aux. in standby, making ripple reading difficult.
- C. Switch X100 SW. to position #0, or remove V17 and read.

- S. Jitter in -Aux. in standby, making ripple reading difficult.
- C. Switch X100 SW. to position #0 and make reading. (Ignore Osc.) or, remove OA3 and read.

- S. High eo in Neg. Aux. while Pos. Aux. is within tolerance.
- C. Switch 6AU8 tubes and both Aux. supplies will come within tolerance in some cases.

- S. Neg. 200 hard to read due to jitter and eo too high.
- C. Remove OA3 to read ripple and ignore Osc. --disappears W/HV on.

301C TROUBLE SHOOTING

S=Sympton

C=Possible Cure

HIGH VOLTAGE RIPPLE

- S. High eo at all outputs.
- C. Try grounding opposite Amp. Fil. lead. Also try by substitution C22, C19, C21 - also 6AG7.

- S. High eo above 110 (W X100 at 1).
- C. Try new 6AU6, V17, or V18.

- S. High eo below 110 (W X100 at 0).
- C. Try new 12AX7 (V19). Also be sure 1.02 v output is not to far off CAL.

- S. High eo at all outputs. Also poor line and load regulation.
- C. Reverse phase or CK2 coil.

301C TROUBLE SHOOTING

S=Symptom
C=Possible Cure

HIGH VOLTAGE RISE

- S. Eo barely rises at all. Very slow and jerky.
- C. Look for intermittent ground or open in chopper circuit.

- S. Slow and decreasing rise - almost stops before reaching set voltage.
- C. Open screen capacitor V17.

- S. Immediate rise to main supply voltage. Does not regulate. Rises and falls with change in line voltage.
- C. Open or disconnected filter capacitor C4. Defective (gassy) 807 tube or bad solder connection, especially on grid pin of 807 socket. 6AG7 tube defective or oriented wrong.

- S. Normal rise, however does not stop at set voltage, but continues to rise to main supply voltage, and fails to regulate.
- C. Since rise rate is proper, the trouble lies ahead of the 12AX7. Things to check are:
 - Standard cell, chopper and AC amplifier and attenuator circuitry.
 - (In some cases lack of reference can result in extremely slow rise rate.)

- S. Supply produces a negative voltage.
- C. Shorted 12AX7 or defect in standard cell circuit.

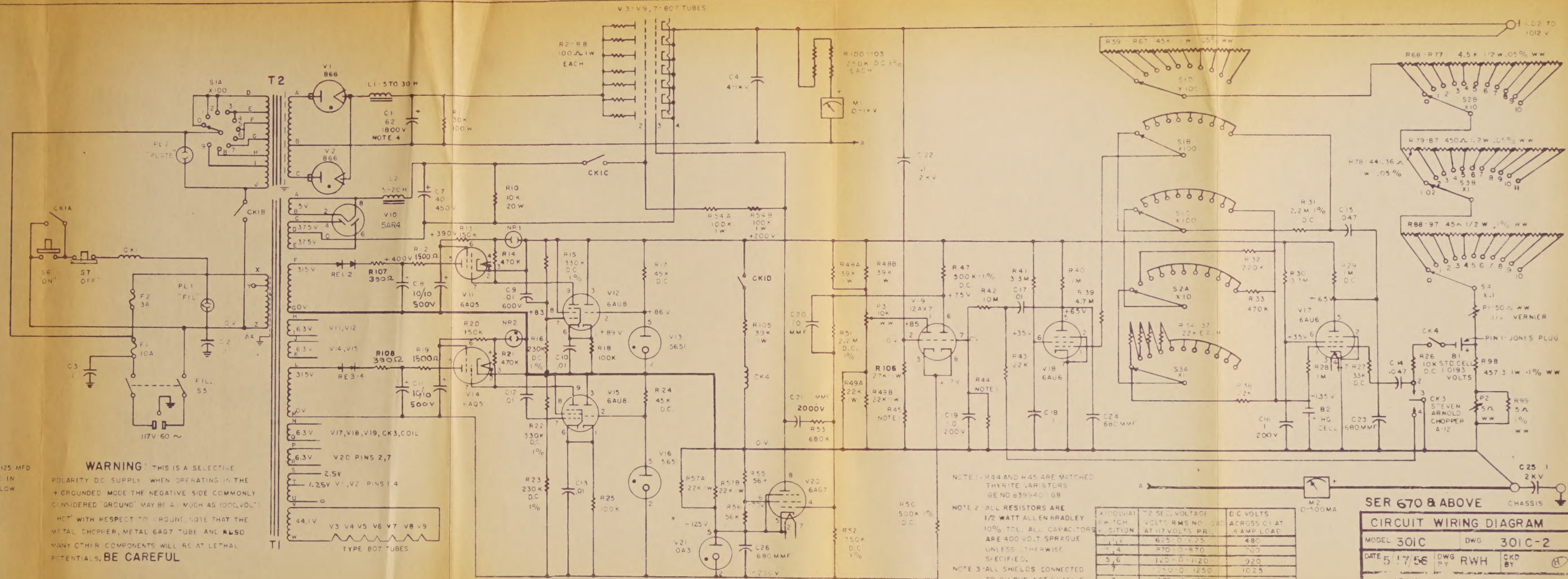
- S. Supply rises slightly fast to set voltage then continues at normal rate to main supply voltage. Won't regulate.
- C. Faulty 12AX7.

- S. Rise rate too fast (more than 125 V/P/S) or too slow (less than 75)
- C. Try new pair of Thyrites (R44 and R45)

- S. Rise rate too fast or too slow (normal is 100 v per second).
- C. Thyrite varisotrs are not in proper 2 to 1 ratio. (R45 feed-back Thyrite should have half the res. of R44 chopper Thyrite).

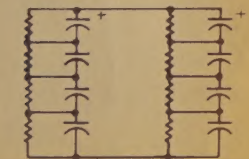
301C CHANGE SCHEDULE (CONTINUED)

CHANGE NUMBER	DATE	DESCRIPTION	STARTING SERIAL NO.
13.	3/13/58	Removed decimal points to left of number on X.1 dial. Added electrostatic shield to aux. & plate xfmr. Relocated CK2 antenna relay beside std. cell New mounting method for Ward-Leonard resistor	211 208
14.	4/17/58	Added CK4 Sigma relay to close std. cell ckt.	207
15.	7/21/58	Reversed P3 (10K pot on PCB) for easy access from front side of supply. Changed R2 thru R8 from 1W to 2W size Relocate twisted leads from PCB to front panel. Now they follow cabinet edge instead of stretching across air gap.	247 232-235
16.	10/9/58	Added 56 ohm RE5 in screen supply ahead of capacitor Plate xfmr, screen supply, standard cell relay and holding contacts all on one relay mounted on bottom pan inside door. 56 ohm resistor mentioned above has been missing since 2/1/59	About 282



NOTE 4: C11 IS COMPRISED OF 8 PIECES OF 125 MFD 450 VOLT CAPACITORS CONNECTED IN SERIES-PARALLEL AS SHOWN BELOW

R9A-R9H
150K-2W EACH
C1A-C1H
125 MFD-450 V



WARNING: THIS IS A SELECTIVE POLARITY D.C. SUPPLY. WHEN OPERATING IN THE + GROUND MODE THE NEGATIVE SIDE COMMONLY CONSIDERED "GROUND" MAY BE AS MUCH AS 100V. VOLTS "HOT" WITH RESPECT TO GROUND. NOTE THAT THE METAL CHOPPER, METAL 6AG7 TUBE AND ALSO MANY OTHER COMPONENTS WILL BE AT LETHAL POTENTIALS. BE CAREFUL

NOTE 1: R44 AND R45 ARE MATCHED THYRISTE VARISTORS GE NO 8399401-GB
NOTE 2: ALL RESISTORS ARE 1/2 WATT ALLEN BRADLEY 10% TOL. ALL CAPACITORS ARE 400 VOLT SPRAGUE UNLESS OTHERWISE SPECIFIED.
NOTE 3: ALL SHIELDS CONNECTED TO 0V BUS, NOT CHASSIS

SWITCH POSITION	2 SEC. VOLTAGE VOLTS RMS NO. 250 AT 17 VOLTS PER DIV	DC VOLTS ACROSS C1 AT 1 AMP LOAD
1	625.0 ± 25	480
2	870.0 ± 870	700
3	120.0 ± 120	920
4	1375.0 ± 1375	1140
5	1500.0 ± 1500	1240

SER 670 & ABOVE

CIRCUIT WIRING DIAGRAM

MODEL 301C	DWG 301C-2
DATE 5/17/56	DWG BY RWH
JOHN FLUKE MFG. CO. INC.	
SEATTLE, WASH.	

